WRIST PIN

[0001] This application claims priority to Provisional Patent Application No. 60/444,421, filed February 3, 2003.

1. Field of the Invention.

[0002] The invention relates generally to piston assemblies for heavy-duty diesel engine applications, and more particularly to wrist pins within the piston assemblies.

2. Related Art

[0003] Conventional piston assemblies for use in internal combustion engines, particularly heavy-duty diesel engines, generally comprise a crown or head portion which acts as a reaction surface for the combustion in the corresponding cylinder of the engine. A pair of laterally spaced pin bosses depend from the piston head and terminate in a pair of coaxial pin bores. A small end of a connecting rod is journaled at one of its ends about a wrist pin, and the wrist pin is journaled within the pin bores.

[0004] Typically, bushings are pressed into the pin bores and the small end of the connecting rod to provide a low friction running surface which reduces wear between the wrist pin and the journaled surfaces. The provision of bushings adds cost and complexity to the construction and manufacture of piston assemblies.

It is an object of the present invention to eliminate the need for such bushings.

SUMMARY OF THE INVENTION

[0005] A wrist pin for a heavy-duty piston assembly has a body with an axis of rotation and a generally cylindrical outer surface. The outer surface is adapted for pivotal connection to both a pair of laterally spaced pin bores and a small end of a connecting rod arranged between the pin bores. The outer surface has a combination of defined characteristics that enable the pin to be utilized without the need for traditional bearings or bushings. According to the invention, the outer surface has a surface roughness equal to or less than 0.10μm, a Kurtosis value that is inversely proportional with the surface roughness such that a product of the Kurtosis value and the surface roughness is between about 0.30μm to 0.60μm, a skewness of about -1.0 to 0.0 and a lay angle relative to the axis of about 85 to 95 degrees.

[0006] One advantage of the present invention is that the bushings typically used in the pin bores and the small end of the connecting rod can be eliminated.

[0007] Another advantage of the invention is that the total cost of a piston assembly can be reduced.

[0008] Another advantage of the invention is that it is of economical manufacture, and readily adaptable in current designs.

[0009] Another advantage of the invention is that the weight of the piston assembly is reduced.

[0010] Another advantage of the invention is that the resulting wear from abrasive contaminants to the bushings is eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] These and other features and advantages of the present invention will become more readily appreciated when considered in connection with the following detailed description and appended drawings, wherein:

[0012] Figure 1 is an exploded perspective view of a piston assembly constructed according to one embodiment of the invention;

[0013] Figure 2 is an enlarged fragmentary sectional view of the assembled components of Figure 1;

[0014] Figure 3 is an enlarged partially sectional plan view of the wrist pin; and

[0015] Figure 4 is a sectional view showing an alternative piston construction.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0016] A piston assembly constructed according to one presently preferred embodiment of the invention is shown generally at **10** in Figures 1 and 2. The assembly has a piston body **12** (cast or forged) having an upper crown portion **14** formed with ring grooves **16** for the accommodation of rings (not shown). A pair of laterally spaced pin bosses **18** depend from the upper crown portion 14 and are formed with pin bores **20** having ground running surfaces **22** fabricated of a metallic material, preferably steel.

[0017] A connecting rod **24**, preferably cast or forged from steel, has a small end 26 formed with a wrist pin bore **28** having a ground running surface **30** alignable with the pin bores **20** of the piston body **12**, as shown in Figure 2.

[0018] A skirt **31** is provided, and may be formed separately from, the piston body **12** from a lightweight material such as aluminum and joined by the wrist pin **32** as shown to provide an articulated structure. Alternatively, the skirt **31** may be formed of one piece with the piston body of the same material in a monobloc construction, as depicted at **3** in Figure 4, wherein the same reference numerals are used to represent like features, but are offset by 100.

[0019] A wrist pin **32** has a body **34** having an axis of rotation **36** and a generally cylindrical outer surface **38**. The outer surface **38** is adapted for pivotal connection to the pin bores **20** of the piston body **12** and the wrist pin bore **28** in the small end **26** of the connecting rod **24**.

[0020] The outer surface **38** of the wrist pin **32** is constructed for rotatable and/or pivotal connection to the pin bores **20** of the piston body **12** and the wrist pin bore **28** of the connecting rod **24** such that the need to incorporate bushings, as are commonly used, in the pin bores **20** and the wrist pin bore **28** is eliminated. Preferably, to reduce the friction between the outer surface **38** of the wrist pin **32** and the bores **20**, **28**, a manganese phosphate $MnP(OH)_2$ coating **40** is applied to the running surfaces **22** of the pin bores **20**, and to the ground running surface **30** of the wrist pin bore **28**. The manganese phosphate is engineered to provide at least in part the necessary tribological properties without having to incorporate the typical bushings within the bores **20**, **28**.

[0021] To inhibit damage from resulting between the outer surface **38** of the wrist pin **32** and the manganese coating **40** within the respective bores **20**, **28**, the outer surface **38** is produced having a surface roughness (R_a) with an arithmetic average deviation of 0.10μm or less. The outer surface **38** also has a Kurtosis value

that is inversely proportional to the surface roughness (R_a) such that a product of the surface roughness (R_a) and the Kurtosis value (K) represented mathematically as (R_a x K) is between about 0.30μm to 0.60μm. In addition, the outer surface **38** has a skewness of about -1.0 to 0.0, and a lay angle α relative to the axis **36** of about 85 to 95 degrees. Preferably, the outer surface **38** has a hardness of about 60 (HRC) or greater.

[0022] Skewness (Sk) can either take on a negative or a positive value. If the skewness is negative, this represents that a larger number of local maxima are above the mean as compared to a Gaussian distribution, which has a skewness value of zero. For a positive skewness, the converse is true, wherein a larger number of local maxima are below the mean as compared to that of a Gaussian distribution.

[0023] Similarly, a surface with a low Kurtosis has a larger number of local maxima above the mean as compared to that of a Gaussian distribution, and a surface with a high Kurtosis has a larger number of local maxima below the mean as compared to that of a Gaussian distribution.

[0024] The surface topography is preferably analyzed using a white light interferometry (WRI) method. In using (WRI), the calculations are based on a square area analysis. As such, rather than obtaining values based simply on a linear reading, as is commonly known, a more representative reading is obtained by taking into account a broader spectrum of the outer surface **38**.

[0025] It should be recognized that in obtaining the specified parameters for the various characteristics of the outer surface **38** outlined above, that the need for bushings in either or both the pin bores **20** and the wrist pin bore **28** may be eliminated. However, if desired, a bushing may be used in either or both bores **20**,

28. If bushings are used, then the useful life of the bushings is enhanced by reducing the amount of scuffing and/or wear to the bushing.

[0026] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. The invention is defined by the claims.